AGRICULTURAL NEWS LETTER

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This publication gives information on new developments of interest to agriculture on laboratory and field investigations of the du Pont Company and its subsidiary companies.

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Agricultural News Letter (du Pont)
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TIME AND RATE ABSORPTION OF PLANT-FOOD BY POTATOES DETERMINED IN A SERIES OF EXPERIMENTS IN VIRGINIA

EDITOR'S NOTE: The following discussion is based on a report made by R. L. Carolus, Virginia Truck Experiment Station, Norfolk (now of the Cornell Experiment Station, Ithaca), in "American Potato Journal", 14, 141-153 (1937). In his paper Carolus gives results of experiments on time and rate of absorption of plant-food by potatoes. His findings offer further evidence of the soundness of the growing emphasis being placed on increasing the nitrogen content of complete fertilizers, using completely available, leaching-resistant sources.

By F. W. Parker, Agronomist,
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The Virginia Truck Experiment Station at Norfolk, in a series of experiments, results of which are reported by R. L. Carolus, set about to determine the seasonal intake of nitrogen, phosphoric acid, potash, magnesia, and lime, by the average potato crop; and also, to indicate at what level mineral absorption should be maintained to facilitate normal growth.

In his report, Carolus points out that more fertilizer is used per acre in producing the potato crop than for any of the other major crops. A ton of 6-6-5 fertilizer is applied per acre to most of Virginia's 60,000-acre early-potato crop, and a similar amount and grade is generally recommended for the entire South and Middle Atlantic section. Therefore, it was deemed advisable to collect information regarding (1) the efficiency of the plant in utilizing the large amount of fertilizer applied; (2) the stage or stages during its growth when maximum absorption occurred; and (3) the optimum level of plant-food absorption by the plant.

Absorption was studied in three fields in the Norfolk district. Each field had been fertilized with approximately one ton of 6-6-5. The average fertilizer application contained 123 pounds of nitrogen, 123 pounds of phosphoric acid, 106 pounds of potash, 50 pounds of magnesia, and an undetermined amount of lime, per acre. Ten uniformly-spaced plants of average size were taken from each field at weekly intervals during the entire growth period from emergence to harvest. Analyses were made of both the plants and tubers to determine the total amount of materials taken into the entire plant to a given date. At the same time, sap was extracted from a five-gram sample of tissue

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from the lower part of the main stem, and analyzed to give some indication of the current absorption of the plant as influenced by availability of the plant-food in the soil.

Growth of Plant and Tubers

The Plant: Six weeks after planting, the entire plant, exclusive of seed, weighed less than 300 pounds per acre. However, by the end of the ninth week, the plant weight had increased to 3,600 pounds, and continued to increase at the same rate until the plant weighed about 6,750 pounds per acre. After this time, the plant lost about 200 pounds per acre daily until harvested on the ninetieth day. It is important to note that 95 per cent of the dry matter was produced during the last one-half of the 90-day growing period.

The Tubers: Eight weeks after planting, only five barrels of tubers per acre had developed, but thereafter for 10 days, the tubers grew at the rate of two barrels daily, and continued this growth rate until the ninetieth day, when they were harvested. The final yield was 53 barrels or 146 bushels per acre. Here again, it is important to note that 95 per cent of the tubers were produced in the last third of the growing season.

In his paper, Carolus gives the total plant-food content of the plant and tubers at weekly intervals. His data have been recalculated to show the amounts of the various plant-food elements absorbed by the crop each week. These data are given in the following table and are shown graphically on the next page.

Period of Growth	Total Plant-Food Absorbed by Plant and Tubers				
	Nitrogen	Phosphoric Acid	Potash	Magnesia	Lime
Weeks	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
0-7	7	1.2	14	0.5	1.0
8	4	1.6	8	0.8	2.0
9	6	2.3	14	1.2	2.5
10	15	4.8	29	2.4	5.0
11	8	3.0	20	1.8	5.5
12	20	7.4	29	3.5	5.0
13	1	0.9	6	1.0	5.0
14	2	0.5	1	1.0	4.0
Total	63	21.7	121	12.2	30.0

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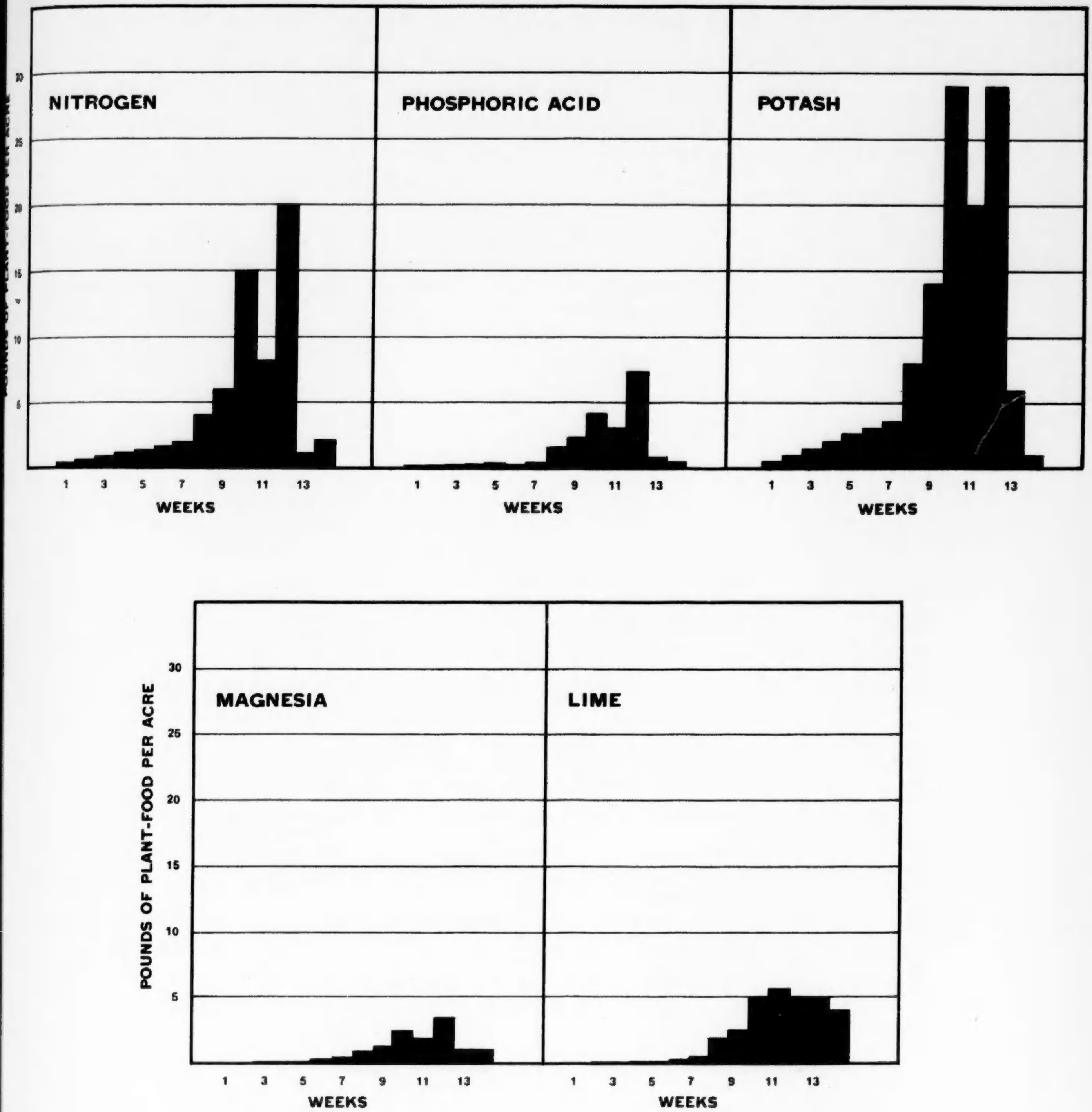

The Amount of Plant-Food Absorbed by Potatoes at Different Stages of Plant Growth

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Nitrogen: While the entire plant absorbed a total of 63 pounds of nitrogen per acre during its fourteen weeks of growth, it used less than seven pounds during the first seven weeks after planting. There was some increase -- a total of 10 pounds being utilized -- during the eighth and ninth weeks. During the tenth week, however, the plant utilized 15 pounds -- almost as much as it had used during the entire first nine weeks of growth. In fact, during the three weeks period covering the tenth, eleventh, and twelfth weeks, a total of 43 pounds, or about two-thirds of all the nitrogen absorbed during the 14 weeks of plant growth, was utilized by the crop, and this despite the fact that only eight pounds were used during the eleventh week due to lack of moisture. During the last two weeks -- the thirteenth and fourteenth -- only three pounds of nitrogen were taken up. The plant stopped growing on about the eightieth day, after which there was a gradual loss from foliage, but a compensating gain in the tubers.

Phosphoric Acid: The rate of absorption of phosphoric acid was very similar to that of nitrogen, but in about one-third the quantity. Of the total of 21.7 pounds of phosphoric acid used per acre by the entire plant, 15.2 pounds or about three-fourths, was absorbed during the tenth, eleventh, and twelfth weeks. About five pounds were taken up during the first nine weeks, of which only 1.2 pounds was used during the first seven weeks. Less than a pound and a half was utilized during the final two weeks of the plant's growth. It is interesting to note that the tubers contained a greater portion of the total phosphoric acid than of the total nitrogen absorbed by the crop.

Potash: The plant absorbed a total of 121 pounds of potash per acre, of which only 14 pounds were used in the first seven weeks of the plant's growth. Again it was during the tenth, eleventh, and twelfth weeks that maximum absorption occurred, a total of 78 pounds, or about two-thirds of the total potash taken up, being used during this three-week period.

Magnesia: The plant used a little over 12 pounds of magnesia during its fourteen weeks of growth, of which only one-half pound was absorbed during the first seven weeks. Again, the period of maximum utilization came during the tenth, eleventh, and twelfth weeks, when a total of 7.7 pounds was taken up. Of this, 3.5 pounds were absorbed during the tenth week alone. The tuber used about 1.75 additional pounds after the eightieth day, making a maximum seasonal requirement of 12.25 pounds per acre.

Lime: One-fourth as much lime as potash was utilized by the potato crop. Practically all of the 30 pounds taken up during the growing season was absorbed during the last seven weeks, only about one pound being used during the first seven weeks. During the eighth and ninth weeks, 4.5 pounds were utilized; and, thereafter, the rate was very uniform, averaging about five pounds each week during the tenth, eleventh, twelfth, and thirteenth weeks, and four pounds during the final week of growth. In his report, Carolus points out that lime in the soil is of indirect value in altering the availability of other plant foods and preventing toxic effects. He states that at maturity the lime content of the plant had reached its peak, and "in this respect differed from any other of the nutrients." The fact that lime was not lost from the plant and was found

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in such small amounts in the tuber -- only 7 per cent of the total absorbed by the crop -- "would help substantiate the theory that some of the other nutrients migrate to the tubers at maturity to supply a pressing need."

Plant-Food Absorption in Relation to Fertilization

These data are of special interest when considered in relation to fertilizer practice. The crop utilizes very little of the fertilizer during the seven weeks following its application. The fertilizer is, therefore, subject to loss by the leaching action of the spring rains. Phosphoric acid, of course, does not leach because it is chemically fixed by the soil. Potash is also chemically fixed by the soil, although in a less stable manner than phosphoric acid. The potash-soil compound is, however, sufficiently stable to effectively prevent leaching during the growing season, except on very sandy soils.

The greatest danger of leaching comes in the case of nitrogen, the most expensive of the three commercial plant foods. The extent to which nitrogen may be lost by leaching may be influenced by the choice of the form or forms of nitrogen used in the fertilizer. The nitrogen in ammonia compounds and ammonia-producing compounds like urea is quite resistant to loss by leaching. Like potash, the ammonium ion is fixed by the soil and is thus protected from leaching. Unlike potash, however, the ammonia is gradually oxidized to the nitrate form, which is not fixed by the soil, and is, therefore, subject to leaching. The conversion of ammonia to nitrate nitrogen is normally slow enough to prevent serious loss by leaching until such time as the crop is utilizing the nitrate nitrogen.

Summary

A study of the absorption of plant food by potatoes in the Norfolk section showed:

(1) That during the first seven weeks, one-half of the planting to harvest period, the crop absorbed only 11 per cent of the total nitrogen, 5 per cent of the phosphoric acid, 10 per cent of the potash, 4 per cent of the magnesia, and 3 per cent of the total lime.

(2) Absorption was most rapid during the tenth, eleventh, and twelfth weeks. This is clearly shown in the graph following page 168. During that three-week period, the crop absorbed 68 per cent of its nitrogen, 65 per cent of its phosphoric acid, 64 per cent of its potash, 63 per cent of its magnesia, and 50 per cent of its lime.

(3) The relationship of these data to fertilization is considered with special reference to possible loss of nitrogen, phosphoric acid, and potash by leaching during the seven week period of low absorption by the crop.

Note: A very interesting article, "Fertilization in Its Relationship to the Course of Nutrient Absorption by Plants" by Th. Remy, was published in "Soil Science", 46, pp. 189-209, September, 1938.

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DESTRUCTIVE PESTS AND THEIR CONTROL PRESENT PROBLEMS REQUIRING CONTINUOUS RESEARCH AND NEW DEVELOPMENTS

EDITOR'S NOTE:- The discussion printed here was originally presented by Dr. Tisdale as an address under the title of "The Unending War on Pests" at a meeting in Wilmington, Delaware.

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In the definitions of Pest we find such words as nuisance, epidemics and disease. At least one of our dictionaries includes certain types of humans in its definition. For this discussion we will consider as pests those living things that cause discomfort, annoyance and diseases of humans and those that compete with the human race for its means of subsistence.

Members of at least one of our worst group of pests, the insects, were well established on the earth long before the appearance of man. Primitive man possibly obtained his first serious mental exercise protecting his body from lice, fleas, mosquitoes and bedbugs, and his food from attacks of flies, cockroaches, ants, and other pests. The war was on and has continued. We find references to plagues, rusts, blights, mildew, locusts and other pests in the earliest preserved writings. The fury of the battle is increasing. There are no signs of a truce. The battle lines are being reinforced on all fronts, and new and effective scientific weapons are being forged by man for a more determined battle for supremacy. There is a question in the minds of many as to whether man will win, or, in some future age join the ranks of the extinct, due to the ravages of pests.

Economic Importance of Pests

Pests of numerous kinds compete with man in many ways for his every means of subsistence. They try to destroy everything. They attack from the air, soil and water in numerous ways. Our animals, plants, foods, clothing, buildings, furniture, ships and numerous other items are damaged or destroyed by them. Humans are tortured with bites, stings, diseases, and death, sometimes in its most horrible forms.

Not only do the pests attack from all sides, they advance in overwhelming numbers. For instance, a prominent entomologist has said that one would have to learn the names of 10,000 species of insects per year for 60 years to know them

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all. Bacteria and fungi or molds can be enumerated in terms of thousands of species. Many of the species of insects, bacteria and fungi are harmless and many are beneficial. The destructive forms, however, run into thousands of species. There are many other kinds of pests which man has to fight, such as rats and other destructive vertebrate animals, weeds, worms, protozoa, and destructive marine life including teredo, barnacles, squids, and algae. Many of these pests, in addition to the direct damage they cause, spread other disease producing pests which may be even more destructive to humans, animals and plants than the pests that spread them. For example, typhoid, malaria, cattle fever, fire blight of apples and pears. In other words their darts are often poisoned.

Not only are there thousands of kinds of pests but practically all of them multiply and develop much more rapidly than man. The Japanese beetle offers an example with which you are familiar. It has been estimated that mosquitoes numbering in billions may result from a single infested rain water barrel during one season. One of the most striking illustrations of the possible rate of reproduction of insects are the published estimates of Professor Herrick of Cornell University concerning the reproduction of the cabbage aphis, a little plant louse. Based on the weight of a single aphis and the number of possible generations in a season in central New York, he showed that, were there food enough, this single aphis could have in a season so many descendants that although each one is extremely small, the mass of the whole would weigh more than 822 million tons. This, he estimated, to be more than five times the weight of all the people of the world. The rate of reproduction of parasitic bacteria and fungi is no less alarming. One molded fruit may carry a sufficient number of spores of the mold fungus to infest several carloads of fruit. One diseased animal may carry sufficient bacteria to infect even millions of others. A small test tube culture of a virulent disease organism such as typhoid, anthrax and others, may carry sufficient germs to destroy thousands of humans or animals. The processes of nature adverse to these pests aided by the battles of man prevent such pests from taking complete possession of the earth. Nature seeks a balance. In spite of the millions of years of advantage of some of these pests in becoming adapted on earth, and in spite of the numerous kinds and enormous numbers of them, man has developed and advanced to his present state of civilization within comparatively few centuries. Progress might have been even greater if men had not taken time to war among themselves.

Expressed in terms of dollars, where it is possible to make estimates of losses caused by pests, the figures available are almost unbelievable. The annoyance, suffering and death caused to humans cannot be expressed in terms of dollars and cents. Cost of control and loss of time are enormous. Losses due to tuberculosis alone have been estimated at one billion dollars annually. Insects are held responsible for an annual loss in the United States of two billion dollars. Our agricultural products suffer a one billion dollar loss due to diseases and decay caused by fungi or molds and bacteria. Weeds take a three billion dollar toll. Damage done by rats and other rodents runs into many millions of dollars. The loss to our shipping caused by marine growths on ship bottoms is estimated at 100 million dollars. These are some of the

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more important items. There are many others in the agricultural and commercial fields. In addition to the direct losses we must add the tremendous cost of control measures which hold these pests within their present bounds.

Methods of Attack Improved

During the earlier periods of territorial expansion it was fairly simple for man to abandon pest ridden areas, especially agricultural lands, and move on. Now that most of our virgin lands, of value, have been occupied it has become necessary to develop more effective means for holding under control the numerous foes which were to some extent responsible for man's migration, and which he unwittingly helped spread through his means of transportation. With the growing density of our population and increasing intensity of our methods of production in industry and agriculture, conditions became more favorable for the spread, multiplication and destructiveness of many kinds of pest.

For ages man fought these enemies principally with his hands. Much of the damage was attributed to unavoidable acts of God. However, during the past century and especially during the past half century, scientific methods of warfare have come into play. Progress has been comparatively rapid. The struggle has just begun. There are many people who seem to be living in the dark ages insofar as their knowledge of many of our important pests are concerned. An important part of the task is to train them for useful service in this battle for the supremacy of humanity.

In our modern warfare against pests scientific methods are being employed. Our Federal and State Governments and numerous endowed institutions and commercial companies are spending millions of dollars annually studying pests and searching for better means of control. With thorough knowledge of the life histories and habits of the pests, the attack can be aimed at the most vulnerable points. Peculiarly enough the attack is often not aimed at the parasite directly but at one of its sources of food supply. In households, storage and factories, careful sanitation solves many of these problems. In the field of human diseases the eradication or control of certain species of mosquitoes effectively controls yellow fever and malaria. Bubonic plague can be held in check by the destruction of rats and other flea carriers. Rocky Mountain spotted fever is known to be carried from rabbits and certain other wild animals to humans by the common woods tick. Protection from tick bites is important. Our farm animals, also, are subjected to infection by similar means. The Texas cattle fever is an example. This destructive disease also is spread by a tick and is now well under control in most parts of the south through tick eradication. We have comparable cases in some of our important plant diseases. The common barberry is a host of the wheat black stem rust fungus. The barberry functions somewhat as the mosquito does in malaria. The Government has spent millions of dollars eradicating the common barberry in our mid-western grain states. Gooseberries and black currants are hosts of the white pine blister rust which threatens the valuable white pine industry of the country. A campaign of eradication of these species in the blister rust infested areas is well under way. Numerous cases of alternate hosts of parasites and the spread of one pest by another, both in the animal and plant

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kingdoms, could be mentioned, but I believe these few illustrate the point. They also serve to emphasize the importance of scientific approach to such problems.

Many Pests are Importations

With our present, although inadequate, knowledge of pests we realize that we were slow in attempting to close our doors against the importation of new and possibly more destructive ones. Our system of commerce is ideal for the spread and propagation of pests. Many of our most destructive pests are known to be importations. In spite of our elaborate and expensive quarantine system, which no doubt has saved us many times its cost, we occasionally have new pests to fight. Extensive efforts to eradicate these newcomers are seldom successful. A good example of a comparatively recent introduction is the Japanese beetle (1916) which was practically harmless in its native Japan. Other examples are the cotton boll weevil, the Mediterranean fruit fly, which we hope is now eradicated from Florida, and more recently still the white fringed beetle which has been found in the south and which has a high potential for destruction. Bacterial and fungus diseases and weeds also spread in a similar way. Once they are introduced and if eradication measures fail the new pests are listed in the ranks of the enemy and it is necessary to reinforce our battle lines. In recent years, scientists have been sent by our Government to other countries to study important pests which may eventually find their way into the States. When introduced without their natural parasites they are often much more destructive than in their native lands.

Well organized surveys keep us regularly informed of the agricultural pest situation throughout the country. It is often possible to predict outbreaks or epidemics far enough in advance to bring control measures into play effectively. These measures of precaution, we hope will enable us to avoid such widespread destruction as was witnessed in the Irish potato famine which was apparently caused by one of our common fungous potato diseases, late blight. However, we have cases of grasshopper devastation in the west and Japanese beetle in the east, and other local pest epidemics which are alarming.

Approaching the actual firing lines - we still do some hand fighting. The boot heel, fly flap, cat for rats, and the hand hoe for weeding, are about as primitive as any of the instruments now in use for war against pests. Barriers such as screens and nets to protect against insects, and guns for destroying harmful animals, are other mechanical means of warfare. These have been greatly improved. They are effective but not adequate. Organized effort with every available means is necessary. Our research laboratories and hospitals are equipped with the best of precision instruments for numerous purposes. For attacking the pests in agriculture and commerce we employ many types of equipment including power machinery operating from land and air. Airplanes are being used extensively now for dusting and to some extent for spraying plants for insect and plant disease control. Equipment for spraying, dusting, pressure treating of wood, soil treatment and household and storage fumigation is highly developed. More extensive use should be made of these improvements. Ray treatments and other electrical appliances are being used.

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Biological means of controlling pests are important. We have many varieties of plants that have been developed through scientific selection and breeding to resist disease. These varieties develop and yield normally where the common varieties are destroyed by diseases. Insect resistant varieties are under development. Advantage is taken of individual and strain differences. Research institutions are spending large sums on investigations of this kind.

The use of serums and vaccines is a well established means of producing immunity or resistance to many diseases in humans and animals. This battle front is not being neglected. There is much yet to be learned.

The successful use of parasites or natural enemies to destroy pests is an accomplished fact. In nature many common and potential pests are held in check by their natural enemies. These enemies include a wide range of kinds and species. A pest introduced into new territory free from its natural enemies, may develop at a rapid rate and cause enormous damage. A study of the pest in its native haunts enables us to find the natural enemies and introduce them. Many of these natural enemies may not be adapted to our conditions but usually some are. Two wasp-like enemies of the Japanese beetle have been introduced into this country and are apparently becoming adapted and we hope will eventually become effective in control. Fluted scale, a small insect, threatened the citrus industry of California. A small lady beetle that feeds on the scale was introduced from Australia and is holding it in check effectively. One of Australias chief weed problems is a cactus plant of the prickly pear type which spreads rapidly. Through a scientific search for a parasite a bacterium was found that destroys the cactus. Following release the parasite is being spread by insects and is proving effective. More should be done toward studying the enemies of pests. Birds, harmless snakes and toads should be protected as an indirect measure. They destroy numerous insect pests.

Chemistry Provides Weapons

Chemical warfare against pests is one of our most effective weapons if properly used. Chemicals are used in many ways, including injections, baths, dips, lotions, sprays, dusts, poison baits, antifouling paints, explosives and gases for pest control. In spite of this array of applications there are many pest problems unsolved or only partially solved. The pests with which we have learned to live but not trust are many.

In the earlier use of chemicals the few then known poisons were employed and some of them are still in use. The gradual increase in the numbers of pests and the resulting demand for more frequent and extensive use of chemicals has aroused the interest of the people over the possibility of poisoning humans who eat treated fruit or other treated food products, or who may in other ways come in contact with excessive amounts of poisonous pest control chemicals. The demand is for safer means of pest control.

Extensive investigations are directed toward improvement along many lines of chemical control. Better stomach and contact insecticides, repellents, attractants, and fumigants and more effective weed killers, fungicides and bactericides, rodent poisons and animal repellents are needed. Effective means of

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removing poisons from fruit and vegetables have been developed. Safety measures for handling poisons have been devised and further studies are under way. Increased efficiency of some of the metallic or cumulative poisons has been developed through the discovery of organic combinations that are many times as effective as the inorganic salts. Improvements also have been made through the use of better assistants, such as wetting, spreading and sticking agents and compatible inerts. By increasing the efficiency, less of the poison is needed and safety hazards are reduced. Still the need is for safer and more effective chemicals. They are hard to find. However, the task does not seem impossible. In the medical field the discovery of sulfanilamide and certain other organics lend much encouragement. The plant products such as pyrethrum and rotenone give us something to aim at. These imported natural plant products are unstable and the supply is uncertain. When synthetic products are found the supply and uniformity can be regulated. Some of the recent discoveries such as certain of the organic thiocyanates, phenothiazine, thiuram sulfides and isobutyl undecylenamide as insecticides offer considerable promise. Salicylanilide as a fungicide, calcium propionate for use in bread as a mold inhibitor and some of the new organic bactericides in the pharmaceutical field represent definite progress.

The field of organic chemistry offers great promise for the future. No nation has a better supply of organic material with which to work than our own. The mystery may not be as great as it seems. Our next step forward in pest control may be the linking together by a skillful chemist of two or more of the chemical elements in our daily food supply to produce an effective weapon against insects or some other destructive pest. The organics are less likely to have cumulative poisonous effects than the inorganics such as the compounds of arsenic, lead, and mercury, which are so commonly used. The organics tend toward specific action. This is what we may logically expect in products that destroy one form of life and not injure another. The metallic compounds are more generalized in their toxic action. Even with the safer chemicals it is important to exercise care. There are limitations. A thing that is poisonous enough to destroy one kind of life would hardly be harmless to another form of life in all proportions or in any proportion under all conditions.

Progress appears to be slow in spite of much that has been accomplished. Organized investigations directed toward more effective means of pest control have not been commensurate with the suffering and tremendous economic losses caused by the multitude of destructive pests. However, there is a real awakening. The battle is between overwhelming numbers and dogged persistence on the part of pests against the intellectual methods of man. Which will win? I should prefer to gamble on the cunning of the human mind.

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ROOT-ROT DISEASES OF CEREALS AND THEIR CONTROL IN CANADA STUDIED BY UNIVERSITY OF SASKATCHEWAN

EDITOR'S NOTE:- While the work discussed here was done in Canada, the findings are important to growers of cereals in the United States, as well. What follows is taken from Agricultural Extension Bulletin No. 92, "Root-Rot Diseases of Cereals" by T. C. Vanterpool, Department of Biology, University of Saskatchewan, College of Agriculture.

Small grain crops are subject to diseases which attack the roots, crowns and stem bases resulting in reduced yield and impaired quality to an extent not fully realized by growers. Indeed, losses from these diseases, collectively known as root rots, are estimated to be upwards of $35,000,000 annually in the prairie provinces alone. These losses, though not overlooked, are frequently attributed to other causes such as alkali injury, wireworm damage, other diseases or climatic extremes of various kinds. True root-rot diseases are caused by parasites of microscopic size known as fungi; these consist of thread-like filaments which, on entering the plant or host, not only live on the food accumulated by the host but also interfere with normal growth, resulting finally in a diseased condition. The parasites are also capable of living in the soil and some may be carried by the seed. They produce small bodies or spores by means of which they reproduce themselves. The root-rot situation frequently represents a disease-complex. Three important types of root rots are recognized, namely, Take-all, Browning and Common Root Rots. By paying proper attention to the control measures for these diseases much can be done to increase the yield and reduce production costs. This pamphlet is prepared to acquaint growers in this province with the various types of root rots which attack small grains, as well as with the measures which have been found helpful in controlling these diseases.

The Root System

A consideration of the root systems of the small grains will help in a better understanding of the factors involved. When a seed germinates it sends out several fine roots which grow rapidly and usually penetrate to a depth of about three feet before midseason. At the same time the shoot grows towards the surface being at first supplied by food substances from the seed itself, but this function as well as that of supplying water is soon taken over by the seminal or primary root system just described, which then continues to maintain the developing seedling until the fourth or fifth week. At this stage, providing there is sufficient moisture present, a second root system, the crown roots, begins to develop near the surface. These crown roots grow rapidly and function along with the primary root system. Food supply and climatic conditions appear to have a greater influence on the number and nature

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of the crown roots than on the primary roots. Shortly following the establishment of the crown root system, tillers form and growth in length occurs. Any measure which encourages the development of a strong root system will therefore be helpful in warding off the damage from root-rotting fungi.

Kinds of Root Rots

Brief descriptions of the various types of root rots with specific measures for the control of each are given in this section.

Take-all.-This disease is of chief importance in the semi-wooded areas of the prairie provinces, appearing most commonly on the second and third wheat crops on newly broken land. On older land it is seldom of any consequence. It usually appears in spots in the wheat fields or more rarely on isolated plants from the time the plants are 8 to 10 inches high. Affected plants are usually stunted and become prematurely bleached instead of the normal golden colour; they may be killed in the seedling stage or may linger on and produce shrivelled grain or none at all. Diseased plants which are easily pulled, have characteristic black decayed roots broken off short and a blackening on the stem bases which can be seen better when the basal leaf-sheaths are torn off. These discolorations are more distinct in wet seasons when the disease is more severe. Occasionally in such seasons small, spherical, black dots, which are actually spore-cases of the fungus, may be found embedded in these leaf-sheaths. Barley, rye, pasture and many wild grasses, as well as wheat, are attacked, but oats are highly resistant. This disease is not seed-borne but lives over winter in the stubble of cereals and in both cultivated and wild grass roots.

In actual farm practice in take-all sections it has been shown that wheat may be sown on new breaking, followed in successive years by oats, wheat again and summer-fallow. Afterwards, recognized rotations may be employed. Should take-all appear again, or in fields known to be diseased, sow to oats or a non-cereal crop, and summer-fallow before sowing to wheat again. Early ploughing allows more time for the destruction of the parasite in the stubble. Special attention should also be given to general recommendations 6 and 9 given below.

Browning Root Rot.- Where this disease appears, it is found only on the summer-fallow crops during June. It is caused by a soil-borne fungus, but its severity is greatly influenced by climate and by cultivation practices. The lower leaves of affected plants turn brown, thus giving a brown appearance to diseased patches which are frequently of large extent. Diseased seedlings have brown, water-soaked markings on their primary and crown roots, usually located at the tips. They are best observed by washing the roots and examining in a white plate. At this critical stage, the disease delays growth, reduces the number of tillers, but seldom kills the plant. As a result, affected patches become thin and weedy, are commonly late in maturing and reduce the yield by as much as ten bushels per acre. The onset of rains in some years has resulted in more or less recovery. Ordinarily, however, compared with the other root rots, browning delays maturity.

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While summer-fallowing tends to decrease the other root rots, it characteristically increases browning in districts where the disease is found. If otherwise suitable, late ploughing of the summer-fallow with a minimum of cultivation afterwards is beneficial. So is the turning under of plenty of weed growth, but weed-seed production must be prevented by discing before ploughing. Farmyard manure applied just before summer-fallowing lessens the trouble.

Triple superphosphate or ammonium phosphate applied to the fallow crop at rates recommended for your district by your nearest Experimental Station will give practical control in most years.

Where feasible the following partial summer-fallow practices may be used: (1) sow a sweet clover and oat mixture, cut the hay crop early the following year and fallow the field the remainder of the season, or (2) fallow the land the first of the season, then sow oats or barley for pasturing off later in the season.

Sweet clover and farmyard manure improve the soil particularly as regards physical texture, nitrogen and organic matter content, but it may still be found necessary to apply phosphatic fertilizer.

Although all the cereals are more or less susceptible, browning root rot is practically confined to wheat in actual practice, as wheat is usually the fallow crop.

Special attention should also be given to general recommendations 4, 5, 6, and 7, outlined below.

Common Root Rot.- This disease may be caused by several parasites capable of acting singly or in various combinations. It shows itself outwardly as a seedling blight, or as a root rot throughout the growing period. Compared with take-all and browning root rots, the common root-rot fungi are seed-borne as shown in severe cases by smudged or by scabby kernels. All the root-rotting fungi may be harboured by the soil. Many of the young seedlings are killed before they reach the surface of the soil. Others after reaching the surface may turn yellow and die. Plants not so severely attacked may be small and unthrifty throughout the season or again may appear normal, but may ripen early and produce little or no grain. Diseased plants do not usually pull as easily as plants diseased with the take-all root rot. They commonly show a brown discoloration of the stem base, crown and roots, without any particular brittleness which is usual with take-all root rot. The seedling blight and the root-rot phases together account for poor germination, weakened plants, thin stands, poor quality grain and low yields. All the cereals suffer from this type of root rot.

Practically all of the suggestions for control under general recommendations given below should be employed for overcoming this root rot, particular attention being given to numbers 1 and 2.

Continued on next page

General Control Recommendations

Besides the particular recommendations found under each type of root rot, the following measures are more or less generally applicable:

1. Sow the best seed available. Shrivelled or otherwise injured grain is liable to produce weakened seedlings unable to resist the soil-borne parasites effectively; they may also be a means of introducing root-rotting fungi into the soil. Injuries received during the seedling stage are usually most serious in reducing yield. Thorough cleaning is therefore advised.

2. Disinfect seed grain with mercury dusts where the seed, or the soil, is heavily contaminated with root-infecting fungi. New Improved Ceresan and Leytosan dusts have been found to be effective in reducing damage caused by seed-borne fungi which attack the roots and stem bases of the cereal seedlings. These dusts are also effective against some of the smuts of cereals.

Formaldehyde treatment, if properly done, will give good control of certain smuts, but may result in reduced germination, increased seedling blight and reduction in yield, thus defeating the purpose of the treatment.

3. Early seeding helps the young plants to escape infection. Also, cereals germinate earlier than weeds in cool soil. Should the soil be very dry and heavily infested with wireworms, later seeding may be desirable.

4. Avoid deep seeding. When sown at a depth greater than three inches, the seedlings are weakened and rendered more liable to attack by root-rotting fungi both before and after emergence.

5. Sow in a firm, clean seed bed. Sub-surface packing may be found generally helpful.

6. Particular attention should be given to the removal of wild grasses which harbour the root-rotting fungi. Strains of the fungi obtained from diseased grasses have been found to be as destructive to cereals as strains obtained from diseased cereals themselves.

7. Crop rotations including legumes or some other non-cereal crop will help to decrease the amount of root-rotting fungi of cereals present in the soil. Such host plants, together with summer-fallowing in the case of take-all and probably common root rot also, tend to starve the root-rotting fungi and allow other soil organisms to hasten their destruction. Oats is probably the least susceptible cereal crop to include in a rotation.

8. Applications of phosphate fertilizers in the drill row in localities where moisture conditions permit will promote rapid growth of the plants and the early establishment of a properly functioning root system, when this is most urgently needed in overcoming attacks of parasites. The phosphate fertilizers do not prevent the disease from occurring; they appear to act as a means of control by stimulating plants in infested areas to a more vigorous development.

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Farmyard manure when used should be applied to the land just before fallowing. The straw in the manure should be well rotted.

9. Avoid sowing wheat after pasture grasses, particularly after western rye grass. Flax is recommended, but if a cereal crop must be sown, oats will probably do best. Slender wheat grass (western rye grass) is especially susceptible to root-rotting fungi.

10. In fields known to be infested with root rot, preference should be given to those wheat varieties showing greatest root-rot resistance, such as Thatcher, Apex, Renown or Marquis. Use those varieties recommended for your district by the University or the nearest Dominion Experimental Station.

Concluding Remarks

With browning and common root rots it is difficult to lessen or remove the sources of infection completely; therefore every possible means should be employed for developing a strong vigorous plant. Most attention should be given to sound seed, seed treatment and rotation practices as given above in general recommendations 1, 2, and 3.

Because of the differences in soil types and climate found in various parts of the province, it should be borne in mind that all of the measures given above will not apply to any one locality. For instance, in some localities, moisture conditions may decide whether or not fertilizers can be applied.

The measures given above have been worked out and checked experimentally by plant pathologists in the province over a period of many years. No amount of recommendations, however, can overcome climatic extremes.

Seed Treatment with Organic Mercury Dusts

Both greenhouse and field experiments have shown that seed disinfection with organic mercury dusts is justified when the seed grain, or the soil in which it is sown, is heavily contaminated with root-rotting fungi. Under such conditions seed treatment increased germination, prevented seedling blight and gave a marked increase in yield; it did not, however, protect plants beyond the seedling stage from becoming attacked by root-infecting fungi living in the soil. Copper carbonate was ineffective in controlling seedling blight or root rot of small grain. Little or no benefit was derived from the disinfection of sound, disease-free seed.

New Improved Ceresan.- In addition to its effects in helping to control seedling blight of cereals as given above, this organic mercury dust gave exceptionally good control of bunt of wheat, covered smut of barley and the smuts of oats in tests conducted in Western Canada. It is applied at the rate of 1/2-oz. per bushel of grain. Present cost of treatment amounts to about 2-1/2 cents per bushel.

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Leytosan.- Half-ounce Leytosan which has replaced One-ounce Leytosan is also available in Western Canada and has given similar protection to cereal grains from seedling blight. It is applied at the rate of 1/2-oz. per bushel of seed. Present cost of treatment amounts to 2-1/2 cents per bushel.

Grain treated with either of these dusts may be stored for several months before seeding.

The organic mercury dusts are poisonous; consequently when treating grain with them it is necessary to protect the face in some way and take other necessary precautions. Treated grain should not be fed to stock. Any left-over treated seed should preferably be sown and the green growth pastured off to stock.

Suitable dusting machines are now available, but adequate application may be secured by thorough mixing of the grain and dust with a shovel.

"Ceresan" is a trade-mark registered in the U. S. Patent Office by Bayer-Semesan Company, Wilmington, Delaware.

Agricultural News Letter (du Pont)
Vol. G, No. 12, December, 1938

EXPERIMENTAL WORK WITH THE INTRODUCTION OF CHEMICALS INTO THE SAP STREAM OF TREES FOR CONTROL OF INSECTS

EDITOR'S NOTE:- The work described here will at once be recognized as a distinct contribution to the conservation of one of the country's most valuable resources. It also is highly important to the farmer and other users of forest products. In making available the results of their experiments Dr. Craighead and Mr. St. George have rendered a real service. The paper is reprinted by special permission of the authors and Journal of Forestry, Washington, D. C. This is part 1; the concluding part will appear in the next number of the News Letter.

By F. C. Craighead and R. A. St. George,
Bureau of Entomology and Plant Quarantine,
United States Department of Agriculture,
Washington, D. C.

The treatment of trees attacked by parasitic organisms by the introduction of chemicals into the sap stream of the living plant has intrigued workers for over 100 years. Considerable serious experimental work has been done, many methods for introducing the chemicals into the sap stream have been patented, and there is a large literature on the subject. Unfortunately, charlatans and quack tree doctors have not been slow to take advantage of such methods, and it should be stated immediately that, to our knowledge, no practical method of killing the parasite without harming the tree has been developed.

Past experimental work in this field has been directed toward a great variety of objectives, such as the preservation of wood from decay; the coloring of the wood for special uses; the treatment of physiological diseases resulting from the deficiency of certain chemicals; the control of fungous diseases, such as chestnut blight, already infecting the trees, and the control of insects attacking the trees, including the sucking, leaf-feeding, and bark-boring types. In practically no cases have fully successful results been obtained. Nevertheless, the possibility of developing a satisfactory technique capable of practical application does not seem to have been exhausted, and from the chemical and physiological standpoints the principles involved would appear to be sound.

For 10 years the Bureau of Entomology and Plant Quarantine has been experimenting in this field for the control of tree-killing insects, chiefly the bark beetles. The more technical phases of the work have been conducted at Asheville, N. C., while large-scale field tests have been made in Virginia, California, Montana, and Idaho, and recently on elm in New Jersey. The results of this work have not been completely successful under all conditions tested, but they have been very encouraging and for some purpose this form of treatment has proved more economical and practical than methods now in use.

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Historical Résumé

The following brief review* of the beginning and development of the chemical treatment of trees (8) will serve to call attention to the wide interest in this field, which in more recent years has come to have practical application in various ways. The main thought behind the initial investigations appears to have been the preservation of wood. Magnol in 1709 (cited by Sachs) (14) was the first to discover the rise of sap in plants. In this work colored solutions were employed to trace the course of the sap stream. Next in importance is the contribution of the English physician Hales (4), who in 1730 recommended to the British Admiralty the boring of holes into the stems of trees and filling them with wood tar. In 1733 De la Baisse presented to the Academy at Bordeaux a paper on the subject of the rise of sap and the ascent of colored liquids in plants. In 1754 Bonnet (1) published a paper dealing with the function of the leaves in connection with the ascent of sap. In 1755 Buffon (2) discussed this same question in his "Natural History". In 1804 Saussure (15) made one of the outstanding contributions of his time by introducing toxic solutions, as well as stains, into the sap stream of trees. Among those used was copper sulphate, which played an important part in the well-known work of his successor Boucherie. Saussure was followed in 1806 by Cotta (3), who applied various salt solutions to growing trees and made them rise in the sap stream. During the next few years, tree injection made noted advances through the efforts of Boucherie, who succeeded in putting the ideas of his predecessors into practical use by working out a method for the impregnation of wood which, with some modifications, was used in Europe (France, Germany, and Austria) for many years, and in recognition of which the French Academy of Science significantly honored him.

Boucherie's first attempts in the field of tree injection relate to boring a hole in the trunk at the base of the tree and, by the aid of a keyhole saw, severing the wood to within an inch of the bark on each side. A solution contained in a barrel was then introduced through a tube by gravity to the bore hole, whence it was rapidly absorbed by the severed tissues in the tree.

Further work in this direction was done in 1841 by Lipowitz (5), who verified Boucherie's findings.

Later Boucherie changed his method of injection because he found it difficult in the case of large trees to make the cut with the keyhole saw. His next step related to the felling of the trees. This soon proved unsatisfactory, however, because it was difficult to handle the larger ones readily while placing the lower end of the severed trunk into a container holding the solution. Because of this he turned his attention again to the standing tree.

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*The early historical summary presented here is largely adapted from Friedrich Moll's paper "Die Impragnierung des Holzes."

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Working with the standing tree, Boucherie made his next injections by using the saw externally. He made a cut which completely encircled the trunk and, by means of a tar-soaked cloth, bandaged the kerf so that it retained the introduced solution until it was absorbed. He was dissatisfied, however, with the results obtained, since distribution was confined mainly to the outer rings of sapwood and, further, much of the solution was lost, as it was taken up into the crown and roots--parts of the tree in which he was not interested, as he was seeking to preserve only the main stem, which could be utilized for ties and for lumber. His objective was to treat the entire cross section, if possible.

Following this he took up again his former idea of felling the trees, but modified his procedure by cutting off all but one limb of the top. In this way he found that it was more nearly possible to accomplish his purpose. To impregnate trees treated in this way, he tied a waterproof bag filled with a solution of copper sulphate over the lower end of the log.

In subsequent tests he completely topped the trees and replaced the bag with a box to serve as a container. With the latter, however, it was necessary to raise the trunk of the tree higher than was the case with the former receptacle. Finally, with further developments, the box was replaced with a board which served as a cap across the end of the cut surface of the trunk. By placing a rubber ring or other similar material around the rim of the section, sufficient space was left within the ring between the inner surface of the board and the end of the log to allow the solution to enter the severed tissues and be distributed throughout the stem.

Boucherie's oldest patents were taken out in 1838, but his principal one was obtained in 1841. The latter covers particularly the impregnation of railroad ties. These tests served as a basis of much of the later work in tree injection. Modifications of this method are numerous, and hundreds of patents have been taken out on methods of injecting trees for various purposes. Today there are some companies which still use a modification of Boucherie's methods to impregnate poles. The way in which this is done is to arrange a series of freshly felled poles in a row, cap the ends, and then introduce a preservative, which comes from a common reservoir that is placed high up on a platform so as to increase the hydrostatic pressure and insure a more thorough impregnation of the wood. In most instances, however, the Boucherie method of impregnation has been replaced by hot and cold dip treatments or by the more modern pressure processes. Also, the corrosive nature of copper sulphate has resulted in its abandonment as a commercial preservative.

In addition to the preservation of wood, the work has extended along other lines as well. Methods have been devised for the coloring of wood, for supplying diseased trees with nutrients and chemicals which they lack, and for introducing toxic substances to protect the wood from the attack of various insects and wood-rotting fungi. The contributions in these fields are too numerous to permit the mention of each of them in this paper, but reference will be made to a few of the most important.

Probably the majority of the papers on tree injection published during recent years relate to the treatment of fruit trees to supply deficient elements. Other contributions have been made in relation to the treatment of trees attacked by fungus diseases and by insects.

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As early as 1903 Mokrzecki (7) in Russia, reported that fruit trees suffering from chlorosis could be successfully treated by injecting solutions of iron salts through bore holes made in the diseased trunks. Since then considerable work has been done in this field.

A notable contribution in relation to the possibilities of controlling fungus diseases is that of Rumbold (10, 11, 12, 13) in Pennsylvania, during the period 1912-14, while she was working with the chestnut blight disease (Endothia parasitica (Murr.) A. & A.). This work demonstrated that injections of dilute solutions of lithium carbonate and lithium hydroxide checked the blight temporarily and caused the infected trees to form considerable callous growth which resulted in cutting off the diseased tissue. As the effect of the chemical was gradually eliminated, however, the trees once more became susceptible to the disease. The work, nevertheless, indicated the possibility of finding a cure for tree diseases by this method. Further, in 1927 Metzger (6), in Germany, mentions the work of Koenig of Hamburg, who treated a series of diseased elms by the bore-hole method of injection. It is stated that the trees responded well to a treatment with a certain fluid. Later several cities in Germany were ordered to test this method.

So far as is known, all attempts to kill insects attacking living trees by means of chemicals introduced into the sap stream and at the same time to save the host have met with little success. Work has been directed at the control of such pests as aphids, various scales, the bronze birch borer, and the locust borer.

Of particular interest is the work of Dr. Otto von Muller (9) in Germany, who tested the effect of many materials on insects and on trees and other plants by introducing chemicals in bore holes made in the stems. Most of his efforts met with little success. He did succeed in controlling aphids under laboratory conditions by the use of a 5 per cent solution of pyridine, but his attempts to repeat this in the field were unsuccessful. In most instances dosages strong enough to kill the insects also injured or killed the host plant.

Another application of the tree-injection principle, and one that has been used most often in recent years, is the poisoning of undesirable tree species for clearing land and for thinning in silvicultural operations. For this work the hack-girdle method has been used principally, and in the severed rings of wood solutions of arsenic, copper sulphate, and other poisons have been applied to the severed tissues in the girdle. Considerable experimental work in this direction has been done by the Forest Service of the United States Department of Agriculture.

Objectives in the Experimental Work

The control of insects attacking forest and shade trees has always presented practical difficulties because of the large size of individual trees and the consequent expensive equipment or large amounts of manual labor required in spraying, felling, and barking the trees or in applying wood preservatives. Obviously the introduction of chemicals into the sap stream of the standing tree will be far more economical if a practical technique can be developed.

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In our work the chief aim has been to develop cheaper, more efficient methods of controlling bark beetle infestations, of preventing insect attacks on certain types of forest products, and of controlling shade-tree pests.

Control of Bark Beetles.- For the control of bark beetles in forest trees federal agencies spend several hundred thousand dollars annually. The cost of treatment ranges from about $1 to $20 per tree, depending on its size and accessibility and the particular method employed. The bark beetles that kill these trees make their attack along the stem in great numbers, boring through the bark and constructing between the bark and wood the tunnels in which the broods develop. The usual practices in control are to fell the tree and burn it or to remove or burn the bark. In all cases the tree dies--often within a week or so after it has been attacked it is beyond recovery--and consequently we are concerned only with killing the insects to prevent their spread to other green trees and not in saving the particular tree treated. Trees killed by bark beetles decay rapidly; therefore a chemical that will kill the bark beetles and, in addition, will preserve the wood and make it possible to utilize the tree some years after, when logging operations go through the area, would be doubly valuable.

For the purpose of bark beetle control, where local labor, often of a mediocre quality, is utilized, very simple methods must be used. From the chemical standpoint a salt is needed that is readily soluble in water, that is nonpoisonous in ordinary quantities to man or the higher animals, and that is effective in relatively small amounts and can therefore be easily transported. Such chemicals as sodium arsenite, sodium arsenate, and bichloride of mercury have given good results from the standpoints of both insect control and wood preservation, but they leave materials in the wood that are dangerous to human and animal life. Zinc chloride and copper sulphate, or blue vitriol, are satisfactory, although the latter has a corrosive effect on metal fasteners such as nails.

In treating coniferous trees infested by bark beetles the most serious difficulty encountered is the stoppage of conduction, and consequent interference with the movement of the chemical solution through the tree, caused by the development of fungi--the so-called blue stains--which the bark beetles introduce at the time they attack the tree. Blue stain development varies greatly, depending on the species of bark beetle, the host tree, and temperature and moisture conditions within the tree. For example, with the southern pine beetle in shortleaf pine in the South, these blue stains will permeate the outer layers of sapwood within 5 to 7 days after attack, and it is rarely if ever possible to obtain effective distribution of the chemical or destruction of the bark beetles unless the trees are treated within this time. This limits the usefulness of this method in the Southeast--in fact, makes it really impractical for forest work. With the mountain pine beetle in white pine, in Idaho and Montana, where development of blue stain is much slower, successful control of the broods can be obtained for 60 or even up to 90 days after the trees have been attacked.

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Several small control operations have been conducted against the mountain pine beetle in white pine on the Coeur d'Alene National Forest in Idaho and on the Kaniksu National Forest in Washington by J. C. Evenden and his staff at the Coeur d'Alene laboratory. The results, after preliminary difficulties were overcome, have been wholly successful and the methods of treatment are much less expensive than those usually employed in that region.* The early partial failures in this work were due to the fact that too long an interval was allowed to elapse between attack by the beetles and the application of the chemical treatment, thus permitting the development of blue stains in the sapwood.

(Concluded in next issue)

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*Described in contemporary paper by Bedard, "Control of the Mountain Pine Beetle by means of Chemicals."

Agricultural News Letter (du Pont)
Vol. 6, No. 12, December, 1938

NYLON DEVELOPED THROUGH DU PONT CHEMICAL RESEARCH OFFERS A WHOLLY NEW AND USEFUL SYNTHETIC MATERIAL

EDITOR'S NOTE:- Readers who have seen comments on nylon in newspapers and other publications will be interested in this authoritative statement.

Development of a wholly new synthetic material of numerous potential uses, one of which may be of revolutionary importance in fine hosiery, was announced recently by E. I. du Pont de Nemours & Company.

Christened "nylon," the new material is considered by the du Pont Company to be one of the most significant developments in the history of industrial research in the United States.

Though wholly fabricated from such common raw materials as coal, water, and air, nylon can be fashioned into filaments of extraordinary strength, fineness, and elasticity.

The new synthetic material is the outgrowth of research that has covered the better part of a decade. Its objective was the synthesis from readily available native raw materials of a wholly new group of chemical compounds capable of meeting deficiencies in certain existing industrial materials that in the main are now imported.

Nylon is the generic name for all materials defined scientifically as synthetic fiber-forming polymeric amides having a protein-like chemical structure; derivable from coal, air, and water, or other substances, and characterized by extreme toughness and strength and the peculiar ability to be formed into fibers and into various shapes, such as bristles and sheets.

Manufacturing Plant to be Built

A sum of more than $8,000,000 has been appropriated to construct near Seaford, Delaware, the first unit of a plant to produce nylon textile yarn. Construction is expected to require 12 months. When completed, this initial plant unit will give employment to approximately 1,000 people.

For several months a pilot plant has been operating near Wilmington to produce small commercial quantities of nylon yarn and "Exton" toothbrush bristles made from nylon. As the output of the pilot plant is limited, nylon will not be widely available until the Seaford plant is operating.

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Du Pont "Exton" bristles are used in the Dr. West's "Miracle-Tuft" toothbrush announced recently in national advertising. The new toothbrush has extraordinary long life, does not shed bristle, is water repellent, and has superior cleansing power.

Like natural silk, nylon is a polyamide having a protein-like structure. Filaments of extreme fineness can be spun -- much finer than the filaments of silk and rayon. The dyeing of nylon presents no particular difficulty. In general it will take dyes used for silk, wool, acetate, and certain of the direct dyes used for cotton or rayon.

Of particular promise among the prospective uses for nylon is high twist yarn for fine hosiery. Hosiery made of nylon possesses extreme sheerness, high elasticity, and high strength.

Nylon textile yarn differs from rayon in that it does not contain cellulose and is not derived from cellulose. In its physical and chemical properties nylon differs radically from all other synthetic fibers.

The nylon business will be conducted by the Nylon Division, Rayon Department of the du Pont Company.

Agricultural News Letter (du Pont)
Vol. 6, No. 12, December, 1938

FLUORINE RESIDUE TOLERANCE ON FRUIT RAISED BY NEW RULING ANNOUNCED BY THE UNITED STATES DEPARTMENT OF AGRICULTURE

EDITOR'S NOTE:-This form letter was received through the Office of Information, United States Department of Agriculture. Formerly, the fluorine residue tolerance was 0.01 grain per pound of fruit.

UNITED STATES DEPARTMENT OF AGRICULTURE

Office of the Secretary

Washington, D. C.

November 14, 1938.

TO GROWERS AND SHIPPERS OF APPLES AND PEARS:

The tolerance for fluorine is set at 0.02 grain per pound, effective immediately. This announcement applies to fruit shipped within the jurisdiction of the Federal Food and Drugs Act.

Very truly yours,

(Signed) H. A. Wallace

Secretary.